REMARKS

Prior to entry of this amendment, claims 1-21 and 30-62 were pending in the application, with claims 19-21 being withdrawn from consideration. This amendment cancels claims 3, 16-17, 30-40, 43-45, 55 and 61 and adds new claims 63-72. New claim 67 is an independent claim; the other new claims are dependent claims.

The undersigned would like to thank the Examiner for the courtesy of a telephone interview on June 8, 2009 to discuss proposed amendments to claims 1, 41 and 42. Agreement was not reached.

The Amendments to the Claims

Claim 1 has been amended to recite that the electrode additionally comprises a substrate and that the nanostructured material is a framework material, that only one layer of the framework material is present in the electrode and that the framework material adheres to the substrate. These amendments are supported by Fig. 3A and its description at paragraph 59 (page 15, lines 2-4) of the specification as filed. Applicants note that page 8, para. 40 of the specification defines a "framework material" as a material into which an electrochemically active species reversibly enters and exits. Applicants note that the limitation that the framework material is in the form of a single layer is not intended to exclude the electrode configurations shown in Figs. 3C, and 3D, in which the substrate (and the layer of nanostructured material) may be folded or rolled. Claim 1 has also been amended to specify that the nanostructured material is in the form of a nanofilm, as supported by original claim 7 and at para. 57, page 13. The limitation that the material may be an alkali metal alloy has been deleted in favor of amended claim 2.

Claim 2 has been amended in view of the amendments to claim 1 and recites that the framework material is alloyed with an alkali metal. This limitation is supported by paragraphs 23 and 24 at page 5 of the specification.

Please delete claim 3 without prejudice.

Claim 4 has been amended to depend from claim 67, rather than deleted claim 3 and to refer to nanoparticles rather than a nanoparticle.

Claim 5 has been amended to refer to nanoparticles rather than a nanoparticle for greater consistency with claim 67.

Claim 6 has been amended to refer to nanoparticles rather than a nanoparticle for greater consistency with claim 67.

Claim 7 has been amended to specify that the nanofilm of framework material is amorphous. This limitation is supported at para. 57, page 14 of the specification as filed.

Claim 8 has been amended to depend from claim 1 rather than claim 7.

Claim 11 has been amended to specify that the alkali metal is lithium in view of the amendment to claims 1 and 2. This amendment is supported by original claim 2.

Please cancel claims 16 and 17 without prejudice.

Claim 18 has been amended to depend from claim 1, rather than claim 17, and specifies that the substrate is made from a metal. This amendment is supported at page 15, para. 60.

Please cancel claims 30-40 without prejudice.

Claim 41 has been amended to recite that the $Si_{(1-z)}Ge_z$ ($0 < z \leq 1$)nanofilm is amorphous. This amendment is supported at page 14, para. 57,

Claim 42 has been amended to recite that the $Si_{(1-z)}Ge_z$ ($0 < z \leq 1$)nanofilm is amorphous prior to electrochemical alloying with the alkali metal. This amendment is supported at page 14, para. 57.

Please cancel claims 43-45 without prejudice.

Claim 46 has been amended to recite that the conductive diluent is a metal or conductive carbonaceous material. This amendment is supported at page 16, para. 61. This paragraph describes conductive diluents as including metal particles or metal films. This paragraph also describes conductive diluents as including carbon black, graphite, carbon nanotubes, and fullerenes, all of which are conductive carbonaceous materials.

For improved clarity, claim 51 has been amended to specify that z is from 0.5 to 0.75. This limitation is supported by Example 9, paragraphs 91 and 92 and Figure 12.

Claims 55 and 61 have been deleted in view of the amendments to claims 41 and 42.

New claim 63 depends from claim 7 and specifies that the nanofilm is not in the form of an aggregate of nanoparticles. This limitation is supported by Example 9, para. 91 (page 25) which states that the appearance of the silicon-germanium thin films was similar to that of the germanium thin films, and by the description of the germanium thin films in Example 4, para. 73 and Figure 5A.

New claim 64 depends from claim 1 and specifies that the electrode is the anode of a secondary electrochemical cell comprising an anode, a cathode, and a

electrolyte. This amendment is supported at para. 23 (page 5) of the application as filed. The limitation that the electrolyte contains a lithium salt is supported by para. 67 (page 17). The limitation that the framework material of the electrode is disposed to allow interaction with the electrolyte is supported by para. 42, which describes electrochemical lithiation of the nanostructured material and its reverse reaction. For electrochemical lithiation of the nanostructured framework material to occur through electrochemical alloying with lithium species from the electrolyte, the framework material must be disposed to allow interaction with the electrolyte. Example 5 also provides characterization results for germanium electrodes following electrochemical lithiation.

New claims 65 and 66 depend from claims 41 and 42, respectively. These claims specify that the electrode is the anode of a secondary electrochemical cell comprising an anode, a cathode, and an electrolyte. This amendment is supported at para. 23 (page 5) of the application as filed. The limitation that the electrolyte contains a lithium salt is supported by para. 67 (page 17). The limitation that the nanostructured material (e.g. the nanofilm) of the electrode is disposed to allow interaction with the electrolyte is supported by para. 42 and Example 5 as described above.

New independent claim 67 recites an electrode for a secondary electrochemical cell comprising a substrate and a nanostructured framework material, wherein the framework material is in the form of nanoparticles and is a silicon-germanium alloy of formula $Si_{(1-z)}Ge_z$, wherein z is greater than 0.5. This claim is supported by original claims 1 and 3 and by paras. 46 and 49 (pages 9 and 10) of the application as filed.

New claim 68 depends from claim 67 and specifies that the framework material is electrochemically alloyed with an alkali metal, while new claim 69 specifies that the alkali metal is lithium. These claims are supported at para. 42, pages 8 and 9 of the specification.

New claim 70 depends from claim 67 and specifies that the electrode further comprises a conductive diluent and the conductive diluent is a metal or conductive carbonaceous material. Claim 70 is supported by para. 61, page 16 of the specification as filed.

New claim 71 specifies that the conductive diluent is capable of binding or alloying with an alkali metal, while new claim 72 specifies that the alkali metal is lithium. Claims 71 and 72 are supported by para. 61, page 16 of the specification.

<u>The Rejection Under 35 U.S.C. 112</u>

Claim 51 was rejected under 35 U.S.C. 112 as being indefinite. Claim 51 has been amended to clarify that the limits of the germanium concentration. The rejection is therefore believed to be obviated by the amendment to claim 51. Reconsideration and withdrawal of the rejection is respectfully requested.

<u>The Rejections Under 35 U.S.C. 102(b)</u>

<u>Saitoh et al.</u>

Claims 1-18, 30-41 and 43-56 were rejected under 35 U.S.C, 102(a)/(e) as being anticipated by U.S. Pre-Grant Publication No. 2003/0165697 to Saitoh et al. (hereinafter Saitoh). Applicants note that claims 3, 16-17, 30-40, 43-45 and 55 have been canceled.

Saitoh describes a semiconductor crystal for a bipolar transistor or a field-effect transistor (page 1, para. 1); no teaching is provided of use of Saitoh's semiconductor crystal as a framework material for a battery. At page 2, paras. 9 and 14 Saitoh discloses a $Si_{1-x-y}Ge_xC_w$ semiconductor crystal including more two or more alternately stacked sets of an $Si_{1-z}Ge_z$ layer ($0<z<1$) which contains a carrier generating impurity and an $Si_{1-w}C_w$ layer ($0.01\leq w<1$) which contains a carrier generating impurity higher in concentration than the $Si_{1-z}Ge_z$ layer.

Therefore, the crystal includes at least two Si-Ge layers. The SiGeC semiconductor crystal is produced via epitaxial growth on a substrate (para. 10); para. 26 teaches epitaxial growth on a silicon substrate. Therefore, Saitoh's semiconductor crystal is not amorphous.

Amended claim 1 recites that the electrode comprises a substrate and a layer of framework nanostructured material wherein only one layer of framework material is present in the electrode. As discussed above, Saitoh teaches combination of multiple $Si_{1-z}Ge_z$ layers with multiple $Si_{1-w}C_w$ layers. Therefore, Saitoh does not teach all the limitations of amended claim 1. Reconsideration and withdrawal of the rejection of claim 1 is respectfully requested. Claims 2, 7-15, 18 and 51 depend from and incorporate all the limitations of claim 1 and therefore are also believed to be allowable over Saitoh.

In addition, amended claim 2 relates to an alkali metal alloy of the framework material. Since Saitoh's compositions do not encompass alkali metal alloys, Saitoh does not teach all the limitations of claim 2 and withdrawal of the rejection of claim 2 is respectfully requested. Since claims 11-12 depend from and incorporate all the limitations of claim 12, withdrawal of the rejection of claims 11-12 is also requested.

Amended claim 4 depends from new claim 67, which relates to an electrode comprising framework material in the form of Ge-Si nanoparticles. Saitoh fails to teach a structure containing Si-Ge nanoparticles. Therefore, Applicants submit that Saitoh does not teach all the limitations of amended claim 4. Claims 5-6 depend from and incorporate all the limitations of claim 4. Applicants respectfully request reconsideration of the rejection of claims 4-6 over Saitoh.

Furthermore, amended claim 7 specifies that the nanofilm is amorphous. Since Saitoh teaches use of crystalline material, rather than amorphous material,

Saitoh does not teach all the limitations of claim 7 and withdrawal of the rejection of claim 7 is respectfully requested.

Amended claim 18 specifies that the current collector is a metal. Saitoh does not teach use of a metallic current collector or substrate. Therefore, Saitoh does not teach all the limitations of claim 18 and withdrawal of the rejection of claim 18 is respectfully requested.

Amended claim 41 specifies that the nanofilm is amorphous. Since Saitoh teaches use of crystalline material, rather than amorphous material, Saitoh does not teach all the limitations of claims 41 and withdrawal of the rejection of claim 41 is respectfully requested. Since claims 52-54 and 56 depend from and incorporate all the limitations of claim 41, withdrawal of the rejection of claims 52-54 and 56 is also requested.

Amended claim 46 specifies that the nanostructured material comprises germanium or germanium alkali metal alloy nanoparticles and a conductive diluent selected from metals and carbonaceous materials. Saitoh fails to teach a structure containing either germanium or germanium alkali metal alloy nanoparticles or a conductive diluent selected from metals and carbonaceous materials. Therefore, reconsideration and withdrawal of the rejection of claim 46 is respectfully requested. Since claims 47-50 depend from and incorporate all the limitations of claim 46, reconsideration and withdrawal of the rejections of claims 47-50 is also requested.

<u>Zhou et al.</u>

Claims 41, 42, 46-50 and 52-62 were rejected under 35 U.S.C. 102(b) as being anticipated by WO 01/96847(hereinafter Zhou). Applicants note that claims 55 and 61 have been canceled.

Amended claim 41 specifies that the nanofilm is amorphous. Zhou does not specifically teach use of amorphous nanostructures. All the x-ray data provided in Zhou indicates crystalline nanostructures. Furthermore, the references cited by Zhou as being suitable for teaching formation of silicon nanostructures and nanostructured germanium do not teach formation of amorphous nanostructures. Zhou teaches that a suitable technique for forming silicon nanostructures and nanostructured Ge is the laser ablation method disclosed in the reference entitled "A Laser Ablation Method for the Synthesis of Crystalline Semiconductor Nanowires' (Morales and Lieber, Science, 279, 209-211, 1998, emphasis added). The other reference cited by Zhou, Zhang et al., Appl. Phys. Lett, 72, 15, 1835-1837, 1998 also teaches formation of crystalline silicon nanowires. (copies of abstracts of these references are attached for the Examiner's convenience as Appendix A). Therefore, Zhou does not specifically teach all the limitations of claim 41.

Zhou provides examples of electrochemical cells incorporating films of silicon rod/wire shaped objects or germanium nanowires and nanoparticles (page 5, lines 4-5, page 6, lines 1-4, and page 7, lines 3-4). Zhou does not teach that any benefit may be obtained through use of amorphous thin films as an electrode material, rather than films of aggregated nanocrystals. The inventors of the present application have found unexpected benefits to the use of amorphous thin films, rather than films of aggregated nanocrystals, as the nanostructured electrode material. In particular, the structure of the initially amorphous Ge thin films of Examples 2 and 4 was found to provide enhanced electrode capacity stability as compared to the Ge nanocrystal aggregates of Examples 1 and 9. Figure 9 of the application shows that the evaporated germanium nanofilm retains greater capacity with increasing numbers of cycles than the layer of germanium nanocrystals. As described at para. 84, page 23 of the application, the stability of the initially amorphous thin film electrode during cycling was surprising given the expected volume expansion of the material during lithiation.

In view of all the foregoing, reconsideration and withdrawal of the rejection of claim 41 is respectfully requested.

Claims 52-54 and 56 depend from and incorporate all the limitations of claim 41. In addition, the Zhou reference fails to teach the additional limitations of claim 53, which relates to an electrode comprising alternating layers of nanofilms and metal films, claim 54, which specifies the nanofilm thickness, and claim 56, which specifies that the nanofilm is a Ge-Si alloy. In view of all the foregoing, reconsideration and withdrawal of the rejections of claims 52-54 and 56 is requested.

Amended claim 42 specifies that the nanofilm is amorphous and not in the form of an aggregate of nanoparticles prior to electrochemical alloying. As previously discussed, Zhou does not specifically teach electrochemical alloying of initially amorphous nanofilms which are not aggregates of nanoparticles. Applicants submit that the structure of a lithiated nanofilm that is initially amorphous and not in the form of an aggregate of nanoparticles is not necessarily the same as that of a lithiated nanocrystal aggregate. A comparison of Figures 6A and 6B of the present application provides evidence for this statement. Figure 6A provides x-ray diffraction (XRD) patterns for ballistically deposited germanium samples before and after electrochemical lithiation while Figure 6B provides XRD patterns of amorphous thin film samples before and after lithiation. The lithiated (Li-Ge) data for the ballistically deposited and amorphous thin film samples is not identical. In view of the foregoing, Zhou does not specifically teach all the limitations of claim 42 and withdrawal of the rejection of claim 42 is respectfully requested.

Claims 57-60 and 62 depend from and incorporate all the limitations of claim 42. In addition, the Zhou reference fails to teach the additional limitations of claim 58, which relates to an electrode comprising alternating layers of nanofilms and metal films, claim 60, which specifies the nanofilm thickness, and claim 62, which

specifies that the nanofilm is a Ge-Si alloy. In view of all the foregoing, reconsideration and withdrawal of the rejections of claims 57-60 and 62 is requested.

Amended claim 46 specifies that the nanostructured material comprises germanium or germanium alkalki metal alloy nanoparticles and a conductive diluent selected from metals and carbonaceous materials. Zhou fails to teach use of a conductive diluent selected from metals and carbonaceous materials. Therefore, Zhou does not specifically teach all the limitations of claim 46 and reconsideration and withdrawal of the rejection of claim 46 is respectfully requested.

Claims 47-50 depend from and incorporate all the limitations of claim 46. In addition, Zhou does not teach the specific multilayer structure of claim 48. In view of all the foregoing, reconsideration and withdrawal of the rejections of claims 47-50 is also requested.

The Rejections Under 35 U.S.C. 103(a)

Sammells et al. in view of Zhou

Claims 42, 46-50, 57-59, 61 and 62 were rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 4,346,152 to Sammells et al (hereinafter Sammells) in view of Zhou. Applicants note that claim 61 has been cancelled.

The Office Action states that at the time of the invention it would have been obvious to one of ordinary skill in the art to optimize the alloy structure size of Sammells as taught by Zhou.

Applicants note that the disclosure of Sammells appears to be limited to bulk materials and that Sammell's example teaches use of germanium particles.

Sammells does not appear to specifically teach use of amorphous materials or use of material in other than particulate form.

Amended claim 42 specifies that the nanofilm is amorphous and not in the form of an aggregate of nanoparticles prior to electrochemical alloying. In view of the preceding discussion of claim 42 with respect to Zhou and the failure of the Sammells reference to cure the deficiencies of Zhou, Applicants respectfully submit that the combination of the Sammells and the Zhou references do not specifically teach the framework material limitations or the resulting alkali metal alloy of claim 42. Therefore, reconsideration and withdrawal of the rejection of claim 42 is respectfully requested. Claims 57-59 and 62 depend from and incorporate all the limitations of claim 42. Therefore, reconsideration and withdrawal of the rejection of claims 57-59 and 62 is also requested.

Claim 46 contains the limitation that the electrode comprises a conductive diluent selected from metals and carbonaceous materials. Neither the Zhou nor the Sammells references appear to teach use of a conductive diluent in the electrode. In the absence of such teaching, Applicants respectfully submit that the combination of the Zhou and Sammells references fails to teach all the limitations of claim 46. Applicants also submit that the combination of the Zhou and Sammells references fails to teach the electrode structure of claim 48. In view of all the foregoing, Applicants respectfully request reconsideration of claim 46 and claims 47-50, which depend from claim 46.

<u>Sammells in view of Zhou and further in view of Kriesel et al.</u>

Claims 30-40 and 60 were rejected under 35 U.S.C. 103(a) as being unpatentable over Sammells in view of Zhou as applied above and further in view of U.S. Pre-Grant Publication No. 2004/0106741 hereinafter Kreisel. Applicants note that claims 30-40 have been cancelled.

The Office Action states that Sammells as modified by Zhou does not teach the specific thickness of the film, but does teach the size of the particles used in the film. The Office Action further states that the size of Zhou's particles would form a very thin nanofilm when used in a coating an asserts that it would have been obvious to one having ordinary skill in the art to optimize the thickness of the nanofilm of Sammels as modified by Zhou as taught by Kriesel. Applicants respectfully disagree, but note that the combination of the Sammells, Zhou and Kriesel references fails to teach the all the limitations of claim 60. Through its dependence from claim 42, claim 60 incorporates the limitation that the Si-Ge or Ge nanofilm is amorphous prior to electrochemical alloying. The combination of the Sammells, Zhou and Kriesel references fails to fairly teach this limitation. Therefore, reconsideration and withdrawal of the rejection of claim 60 is respectfully requested.

The New Claims

Claims 63 and 64 depend from claim 1, which is believed to be in condition for allowance. Therefore, claims 63 and 64 are believed to be in condition for allowance.

Claim 65 depends from claim 41, which is believed to be in condition for allowance. Therefore, claim 65 is believed to be in condition for allowance.

Claim 66 depends from claim 42, which is believed to be in condition for allowance. Therefore, claim 67 is also believed to be in condition for allowance.

Claim 67 recites that the electrode comprises framework material in the form of particles, the framework material having the composition $Si_{(1-z)}Ge_z$, wherein z is greater than 0.5. This electrode structure and composition is not believed to be taught by the references cited in the Office Action, either singly or in combination. Therefore, claim 67 and dependent claims 68-72 are believed to be in condition for allowance.

Conclusion

All claims being in condition for allowance, passage to issuance is respectfully requested.

Applicants hereby request that an extension of time be granted for the filing of this response. It is believed that a fee of $555, for a three months extension of time, is due with this submission. It is believed that no claims fees are due since the number of dependent claims canceled in this response exceeds the number of dependent claims added and the number of independent claims added equals the number of independent claims canceled. If the amount submitted during EFS filing of this response is incorrect, please charge any deficiency or credit any overpayment to deposit account 07-1969.

Respectfully submitted.

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